ABSTRACT

Digital imaging is very essential in many applications such as object recognition, biomedical instrumentation, satellite imaging, entertainment media, internet etc. Images are frequently corrupted by impulse noise which occurs in the process of image acquisition, transmission and storage. The acquired image signal must be noise free to convey meaningful information to the end user and to have very good visual presentations in applications like mobile phones, medical imaging, entertainment media etc. Thus an effective de-noising algorithm is essential to remove noise in images.

The overall objective of this thesis is to develop new and novel restoration algorithms for suppressing both Salt and Pepper Noise (SPN) and Random Valued Impulse Noise (RVIN) in digital images. The performance of the proposed filters is evaluated both by quantitative standards as well as visual quality. The metrics that are used as quantitative measures are viz., Peak Signal to Noise Ratio(PSNR), Mean Square Error(MSE), Structural Similarity Index(SSIM) and Image Enhancement Factor(IEF). The qualitative analysis of the restored images is observed by the human eye and the valuation focuses on the clarity of the image, presence of noise patches and preservation of edges and fine details.
First, a new Morphological based Adaptive Unsymmetrically Trimmed Mid-Point Filter (MAUTMPF) is presented to remove salt and pepper noise, in which, the corrupted pixels in the image are replaced by the mid value of the maximum and minimum pixel intensity values, after unsymmetrically trimming all the corrupted pixels in the selected window. Experimental evaluation revealed that the proposed MAUTMPF demonstrates superior visual quality and found better improvement in terms of PSNR, MSE, SSIM and IEF compared to the existing algorithms both at high and low noise densities.

Next a Two Stage Mid-Point Filter (TSMF), which is a modified version of MAUTMPF is proposed, in which the result of the trimmed mid-point algorithm is compared with the results of the already processed pixels in the selected window and the corrupted pixels are replaced by the optimum value by using thresholding techniques. The experimental evaluation of TSMF demonstrates better performance when compared to MAUTMPF and other existing methods.

As a third approach new and Novel Eight Window Trimmed Mid-Point Filter (NEWTMPF) is developed to suppress SPN. The size of the window is fixed to be 3 x 3 and filtering is carried out using suitable neighbourhood windows, which achieves effective preservation of edges and fine details. The subjective visual quality of the restored images using NEWTMPF is extra-ordinarily good and also it is observed that, the filter
performs well even at very high density of 95% noise density. The performance of NEWTMPF in terms of SSIM and IEF shows superior performance for all test images even at higher noise densities.

As an another approach, Adaptive Threshold Intensity Range Filter (ATIRF) is proposed for suppressing RVIN. The visual quality of the denoised images processed by ATIRF shows that ATIRF suppresses RVIN very effectively and efficiently. Even at high noise density of 60%, the filter preserves edges and fine details of the image irrespective of the nature of the image. The proposed ATIRF demonstrates significant improvement of PSNR value when compared to the best of the approaches mentioned in the literature. It is observed that, ATIRF demonstrates better SSIM and IEF values for all test images even at 60% noise density. In addition, ATIRF demonstrates better performance with respect to miss and false detections.

Next, a novel directional detection technique is introduced for effective detection of corrupted pixels and to suppress RVIN. The novelty of this proposed filter is that the direction of scan being the shape of alphabets X, Y and Z, which helps to preserve edges and fine details in the restored images. In addition, the proposed XYZDF approach produces better image quality even at higher NDs. The proposed XYZDF demonstrates significant improvement of PSNR values and exhibits better SSIM and IEF values for all test images. The detection performance of XYZDF algorithm is better irrespective of the input image and hence effective filtering is also achieved even for high noise densities.
The proposed filters and filters used for comparison are implemented using MATLAB 7.8 on a PC equipped with 2.6 GHz CPU and 2 GB RAM memory and tested with different standard 8 bit gray scale images of size 512 x 512.

An investigation of the performances of the proposed filtering schemes reveals that NEWTMPF performs better compared to MAUTMPF and TSMPF schemes in suppressing SPN, and XYZDF performs better compared to ATIRF in suppressing RVIN.